elements of a particular order in a finite cyclic group; number of generators for finite and infinite cyclic groups.

Left and right cosets, Lagrange's theorem, converse is true for cyclic groups, not true in general, applications of Lagrange's theorem (Fermat's little theorem, etc.); normal subgroups, properties and characterisation of normal subgroups, Simple groups, `Simple subgroups of abelian groups are cyclic of prime order.'; quotient groups; group homomorphism and isomorphism, automorphism, Fundamental Theorem of Homomorphism, correspondence between subgroups of G/H and subgroups of G that contain H, three isomorphism theorems.

Permutation groups, cycle decomposition, alternating group, Cayley's theorem.

(Optional: Direct product, Sylow theorems (without proof), classifying groups of orders 1 to 10.)

Rings, elementary properties, Z_n, polynomial rings, matrix rings over $\mathbb{R}$, C, Zn, rings of the form $\{a+b\sqrt{n}$, a, b, n are integers and n is not a square$\}$, ring of continuous functions, ring of differentiable functions, Cartesian product of rings is again a ring. Commutative and non-commutative rings; subrings, examples of subrings in matrix rings, polynomial rings, characterisation, properties, algebra of subrings(Intersection, direct product are rings, etc.); ideals, properties of ideals (sum, product, intersection), prime ideal, maximal ideal; quotient rings; Ring homomorphism and isomorphism, properties, isomorphism theorems.

Zero divisors, integral domain, definition of a field, `Every finite integral domain is a field.', characteristic of an integral domain, field of quotients of an integral domain; Ring of Polynomials, properties of R[x] (the polynomial ring over a ring R), the division algorithm in F[X], F a field; roots of polynomials, statement of the Fundamental Theorem of Algebra, field of rational functions.

(Optional: Euclidean Domains, Gaussian Integers, primes, factorisation into primes; principal ideal domains, units, irreducible and prime elements, associates, unique factorisation domains, Eisenstein’s criterion for irreducibility of polynomials over $\mathbb{Q}$.)

9.1.6 Physics

Course Code: BPHCT-131	Course Title: Mechanics	4 Credits

Mathematical Preliminaries: Geometrical and algebraic representation of vectors, vector algebra, scalar and vector products, derivatives of a vector with respect to a scalar. First order homogeneous ordinary differential equations, separable and linear first order ordinary differential equations. Second order homogeneous ordinary differential equations with constant coefficients.

Basic Concepts of Mechanics: Newton’s laws of motion, frames of reference, straight line motion, motion in a plane, uniform circular motion, 3-d motion. Applications of Newton’s law of motion, friction, tension, gravitation, spring-mass system – Hooke’s law. Satellite in circular orbit and applications, geosynchronous orbits, basic idea of global positioning system (GPS). Weight and weightlessness. Linear momentum, conservation of linear momentum, impulse, impulse-momentum theorem, motion of rockets. Work and energy, conservation of energy. Kinematics of angular motion, angular displacement, angular velocity and angular acceleration, general angular motion. Dynamics of rotational motion, torque, rotational inertia, kinetic energy of rotation, angular momentum, conservation of angular momentum and its applications. Motion of a particle in a central force field, motion in a plane,

conservation of angular momentum, constancy of areal velocity, Kepler's laws (statement only).

Many Particle Systems: centre of mass, determination of the centre of mass of discrete mass distributions, centre of mass of a rigid body (qualitative), dynamics of a system of particles, linear momentum, angular momentum and energy conservation laws for many particle systems. Head-on and 2-d collisions.

Harmonic Oscillations: Simple harmonic motion, differential equation of SHM and its solutions, kinetic energy, potential energy, and total energy of SHM and their time averages. Superposition of harmonic oscillations, linearity and superposition principle, superposition of collinear oscillations having equal frequencies and having different frequencies (beats), superposition of orthogonal oscillations with equal and unequal frequency, Lissajous figures and their uses. Damped oscillations, equation of motion of damped oscillations and its solution (without derivation), qualitative description of the solution for heavy, critical and weak damping, characterising damped oscillations, logarithmic decrement, relaxation time and quality factor. Wave motion, qualitative description, wave formation and propagation, describing wave motion, frequency, wavelength and velocity of wave, mathematical description of wave motion.

Course Code: BPHCL-132	Course Title: Mechanics Laboratory	2 Credits

Unit I: Measurements and error analysis.

Unit II: Graphing.

List of Experiments

1. Length measurement.
2. Determination of moment of inertia of a fly wheel about its axis of rotation.
3. Determination of Young's modulus by bending of beams.
4. Determination of the modulus of rigidity of a wire using Maxwell's needle.
5. Determination of elastic constants of a wire by Searle's method.
6. Determination of acceleration due to gravity using bar pendulum.
7. Determination of acceleration due to gravity by Kater's pendulum.
8. Study of the motion of a spring-mass system: determination of spring constant and value of acceleration due to gravity.
9. Determination of frequency of tuning fork using sonometer.
10. Study of Lissajous figures using a cathode ray oscilloscope.

Course Code: BPHCT-133	Course Title: Electricity and Magnetism	4 Credits

Vector Analysis: Brief review of vector algebra (scalar and vector products). Scalar fields and their gradient and its significance.Vector fields, divergence and curl of vector field and their significance. Vector integration, line and surface integrals of vector fields, volume integrals. Vector integral theorems, divergence theorem and Stoke's theorem (statement only).

Electrostatics: Electrostatic force and electric field, electric flux, Gauss's law of electrostatics. Applications of Gauss's law - electric field due to point charge, uniformly charged spherical shell and solid sphere, infinite line of charge, plane charged sheet, charged conductor.

Electric potential, electric potential as line integral of electric field, potential due to a point charge, potential due to a system of charges, calculation of electric field from potential, electric field and potential due to electric dipole, electric dipole in an electric field. Electric potential due to continuous charge distributions, line charge, uniformly charged spherical shell and uniformly charged non-conducting solid sphere, equipotential surfaces, electrostatic potential energy.

Electrostatics in Medium and Magnetism: Dielectric medium, dielectric in electric field, polarisation, displacement vector, Gauss's law in dielectrics. Capacitors, capacitance of an isolated spherical conductor, parallel plate, spherical and cylindrical capacitors, parallel plate capacitor completely filled with dielectric, energy per unit volume in electrostatic field. Magnetic field, electric current and magnetism, current density, continuity equation, source of magnetic field, Gauss's law for magnetism, Biot-Savart law and its applications – long straight wire carrying current and circular coil, force between two parallel conductors – definition of Ampere. Ampere's law, applications of Ampere's law – long straight current carrying wire and current carrying solenoid, differential form of Ampere's law, divergence and curl of magnetic field, magnetic vector potential. Magnetic properties of materials, magnetic induction, magnetic intensity, permeability, magnetic susceptibility, brief introduction of diamagnetic, paramagnetic and ferromagnetic materials.

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, self-inductance of single coil, mutual inductance of two coils. Energy stored in magnetic field. Equation of continuity for current, displacement current, Maxwell's equations, electromagnetic waves, transverse nature of electromagnetic waves. Electromagnetic wave propagation through vacuum and isotropic dielectric medium, Poynting vector, energy density in electromagnetic field.

Course Code: BPHCL-134	Course Title: Electricity and Magnetism: Laboratory	2 Credits

List of Experiments

1. Measurements with a multimeter.
2. Study of magnetisation intensity in a magnetic material.
3. Study of a series *RC* circuit.
4. Study of a series *LCR* circuit.
5. Study a parallel *LCR* circuit.
6. Determination of low resistance by Carey Foster's bridge.
7. Verification of Thevenin and Norton theorems.
8. Verification of superposition and maximum power transfer theorems.
9. *I-V* characteristics of a *p-n* junction diode.
10. Study of half-wave/full-wave rectifiers and filter circuits.

Course Code: BPHCT-135	Course Title: Thermal Physics and Statistical Mechanics	4 Credits

Kinetic Theory of Gases: Expression for pressure (no derivation), kinetic interpretation of temperature and derivation of gas laws, real gases (van der Waals equation, qualitative discussion). Derivation of Maxwell's law of distribution of velocities and its experimental

verification, expression for average speed $(\bar{v})$, most probable speed (v_p), and root mean square (v_{rms}), law of equipartition of energy (no derivation) and its applications to specific heat of gases, monoatomic and diatomic gases. Mean free path (zeroth order). Transport phenomena, viscosity, conduction and diffusion (discussion of physical implications only, no derivation). Brownian motion (no derivation) and its significance, sedimentation, Perrin's experiment.

The Zeroth Law and The First Law of Thermodynamics: Boundaries, variables, processes (reversible and irreversible), graphical description. Statement of zeroth law, introduction of concept of temperature, applications of the zeroth law. Compressibility and expansion coefficient. First law of thermodynamics, statement, parametric form, mathematical form (integral and differential), relation between c_p and c_v, work done during isothermal and adiabatic processes, velocity of sound.

The Second and Third Law of Thermodynamics: Heat engines, conversion of heat into work, Carnot cycle, efficiency of a Carnot engine, Carnot theorem, Kelvin-Planck and Clausius statements of second law of thermodynamics, equivalence of Kelvin-Planck and Clausius statements. Entropy, second law and entropy, entropy changes in reversible and irreversible processes, entropy-temperature diagram, statement and consequences of the third law of thermodynamics (unattainability of absolute zero temperature, etc.). Thermodynamic potentials, enthalpy, Gibbs, Helmholtz and internal energy functions, Maxwell's relations and their applications, Clausius-Clapeyron equation, Joule Thomson effect, TdS equations. Black body radiation, spectral distribution, concept of energy density, derivation of Planck's law, deduction of laws of radiation (Wien's distribution law, Rayleigh-Jeans law, Stefan Boltzmann law and Wien's displacement law).

Statistical Mechanics: Phase space, macrostate and microstate, entropy and thermodynamics probability, distribution function. Maxwell-Boltzmann law, partition function of a monoatomic gas and deduction of thermodynamic functions. Need for quantum statistics, Bose-Einstein distribution function, Bose-Einstein photon gas, Fermi-Dirac distribution function, strongly degenerate Fermi system, Fermi energy, electronic heat capacity, comparison of the three statistics.

Course Code: BPHCL-136	**Course Title: Thermal Physics and Statistical Mechanics: Laboratory**	**2 Credits**

List of Experiments

1. Measurement of Planck's constant using black body radiation.
2. Determination of Stefan's constant using black body radiation.
3. Determination of the coefficient of thermal conductivity of copper by Searle's apparatus.
4. Determination of the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
5. Study of variation of thermo-emf with temperature.
6. Determination of specific heat capacity of liquid using the method of cooling.
7. Study of temperature variation of surface tension of a liquid.
8. Study of phase transitions and interpretation of cooling curves.

9. Determination of specific heat of a liquid using a calorimeter.
10. Determination of the temperature coefficient of resistance by platinum resistance thermometer.

Course Code: BPHCT-137	Course Title: Waves and Optics	4 Credits

Waves: Transverse waves on a string, wave formation and propagation, relation between wavelength and frequency, wave velocity, mathematical description of wave motion, types of waves – plane waves and spherical waves (*qualitative description only*), energy carried by waves, intensity of waves. Superposition principle for waves, travelling and standing waves on a string, normal modes of a string, group velocity, phase velocity. Acoustic waves, production of sound waves – forced vibrations and resonance, intensity and loudness of sound, decibels, intensity levels, musical notes, musical scale, acoustics of buildings. Electromagnetic waves, wave equation for electromagnetic waves, electromagnetic nature of light, definition and properties of wave front, Huygens principle. Polarisation, transverse nature of light waves, production and analysis plane polarised light, Malus' law, Brewster's law, double refraction, Nicol prism, wave plates, circular and elliptical polarisation.

Interference: Interference by division of wave front, Young's double slit experiment, white light fringes, displacement of fringes, Lloyd's mirror and Fresnel's biprism. Interference by division of amplitude, phase change on reflection – Stokes' treatment, interference in thin films, qualitative description of Fringes of equal inclination (Haidinger fringes) and fringes of equal thickness (Fizeau fringes), interference in wedge-shaped films, Newton's rings – measurement of wavelength and refractive index. Michelson's interferometer, qualitative idea of the form of fringes, determination of wavelength, wavelength difference, refractive index and visibility of fringes.

Diffraction: Fresnel diffraction, Fresnel construction, half-period element, the zone plate, diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. Fraunhofer diffraction, evolution from Fresnel to Fraunhofer diffraction, diffraction from a single slit - observed pattern, intensity distribution; diffraction from a double slit – observed pattern, intensity distribution. Diffraction grating, Fraunhofer diffraction from multiple slits, intensity distribution, principal maxima, minima and secondary maxima, angular half-width of principal maxima.

Lasers and Optical Fibre: Basic principles of lasers, emission and absorption of light, spontaneous and stimulated emission, Einstein's relations (general idea only), population inversion, optical pumping, pumping mechanisms, three and four level pumping schemes, feedback mechanism, optical resonant cavity. Types of lasers and their applications, solid state, liquid and gas lasers, Helium-Neon laser, applications of lasers in communication, medicine, industry and photography. Optical fibre, core and cladding materials and their refractive indices, propagation of light through optical fibre - total internal reflection, types of fibres – step index and gradient index fibres, refractive index profiles, optical communication through fibres, qualitative idea of pulse dispersion and its reduction, material dispersion and power loss.

Course Code: BPHCL-138	Course Title: Waves and Optics: Laboratory	2 Credits

List of Experiments:

1. Refractive index of the material of a given prism.

2. Investigations with polarised light using polarimeter.
3. Determination of the value of Cauchy constant of the material of a prism using mercury light.
4. Determination of wavelength of sodium light using Fresnel biprism.
5. Determination of wavelength of sodium light using Newton's rings.
6. Determination of wavelength of sodium/ mercury light using plane diffraction grating.
7. Determination of dispersive power of the material of a given prism using mercury light.
8. Determination of resolving power of a prism.
9. Determination of wavelength of laser light using diffraction from a thin wire.
10. Study of the intensity of single slit diffraction pattern of a laser using photo sensor.

9.1.7 Zoology

Course Code: BZYCT-131	Course Title: Animal Diversity	Credits: 4

Animal Like Protists: Protozoans: General Characters; Classification: Super Group Excavata, Super Group 'SAR' Clade, Super Group Unikonta; Structural Organisation and Function: Body Form, Nutrition, Osmoregulation and Excretion, Respiration, Mechanism for Response, Reproduction; Locomotion in Protozoans: Structure and Function Cilia and Flagella.

Animal Classification and Architecture: Classification of Living Organisms: Binomial Naming of Organisms, Concept of Species, Classifying Organisms, Modern Classification System; Organisation and Body Plan: Symmetry and Cephalisation, Germ Layers and Body Cavity, Developmental Patterns, Segmentation; Origin and Diversification of Metazoa: Origin of Multicellularity, Diversification and Phylogeny of Animals.

Phylum Porifera: Porifera (Sponges): Characteristic Features, Classification; Canal System: Asconoid Type, Syconoid Type, Leuconoid Type.

Phylum Cnidaraia: Characteristic Features of Phylum Cnidaria; Classification of Phylum Cnidaria; Polymorphism in Cndiaria: Polymorphism in Hydrozoa.

Phylum Platyhelminthes: Platyhelminthes: Characteristic Features, Classification; Life Cycle of *Taenia Solium*.

Phylum Nematoda: Nematoda: Characteristic Features, Classification of Nematoda; Life Cycle of *Ascaris Lumbricoides*; Parasitc Adaptations in *Ascaris Lumbricoides*.

Phylum Annelida: Coelimata – Eucoelomata – Phylum Annelida: The Coelom, Metamerism (Segmentation); Characteristic Features of Phylum Annelida; Classification of Phylum Annelida.

Phylum Arthropoda: General Characters of Arthropoda; Characteristic Features of Arthropoda; Classification of Phylum Arthropoda, Subphylum Trilobitomorpha, Subphylum Chelicerata, Subphylum Crustacea, Subphylum Uniramia; Vision in Arthropods, Metamorphosis in Insects.

Phylum Mollusca: Characteristics of Mollusca; A Generalised Mollusc; Classification of Phylum Mollusca: Monoplacophora, Polyplacophora, Aplacophora, Gastropoda, Bivalvia, Scaphopoda, Cephalopoda.